Claims:

1. A data transmission apparatus for transmitting data packets from a network layer side device and a physical layer side device, comprising:
a first receiving means for receiving the data packets of a certain type from the network layer side device;
SAPI identifier generating means for recognizing the type of the data packets and generating a SAPI identifier according to the recognized type;
first framing means for encapsulating a SAPI field including said SAPI identifier and an information field including said data packets into a frame, to form a first type of frames;
second framing means for encapsulating said first type of frames into a payload portion, inserting appropriate overheads, to form a second type of frames;
a first transmitting means for outputting said second type of frames to the physical layer side device.

2. The data transmission apparatus according to claim 1, wherein said first framing means encapsulates said data in a format of start flag, SAPI field including said SAPI identifier as address field, control field, information field including said data packets, FCS field, and end flag to form the first type of frames.

3. The data transmission apparatus according to claim 2, wherein said SAPI field is of one single octet, and said control field is of one single octet.

4. The data transmission apparatus according to claim 1, wherein said first framing means encapsulates said data in a format of start flag, address field, control field, SAPI field including said SAPI identifier, information field including said data packets, FCS field, and end flag to form the first type of frames.

5. The data transmission apparatus according to claim 4, further comprising a frame type indicator generating means for generating an indicator which indicates the type of said first type of frames, and said frame type indicator is inserted in the address field by said first framing means.

6. The data transmission apparatus according to claim 5, wherein said address field is of one single octet, said control field is of one single octet, and said SAPI field is of two octets.

7. The data transmission apparatus according to claim 3 or 6, further comprising a self-synchronizing scrambling means for performing $X^{43}+1$ scrambling, said scrambling means includes a XOR gate and a 43-bit shift register, and the output bits is exclusive-ored with the raw input data bits to produce the transmitted bits.

8. The data transmission apparatus according to claim 7, further comprising a pointer inserting means for inserting pointer which indicates the start position of the payload portion in said first type of frames.

9. The data transmission apparatus according to claim 8, wherein said first receiving means is a first FIFO for receiving and buffering the input data packets.

10. The data transmission apparatus according to claim 9, wherein said start flag and end flag are "0x7E".

11. The data transmission apparatus according to claim 10, wherein said first framing means performs inter-frame fill.

12. The data transmission apparatus according to claim 11, wherein said first framing means performs transparency processing(octet stuffing) to encode 0x7E as 0x7D,0x5E, and 0x7D as 0x7D,0x5D.

13. The data transmission apparatus according to claim 12, wherein said first framing means calculates 32 bit frame check sequence field over all octets within the frame except the start flag and the end flag and the FCS field itself, with generating polynomial: $1 + x + x^2+ x^4+ x^5+ x^7+x^8+ x^{10}+ x^{11}+ x^{12}+ x^{16}+ x^{22}+ x^{23}+ x^{26}+ x^{32}$.

14. The data transmission apparatus according to claim 13, wherein said payload portion includes a plurality of sub-portions of payload for carrying said first type of

frames, and the boundaries of said first type of frames are aligned with the boundaries of the payload portion.

15. The data transmission apparatus according to claim 14, wherein said SAPI generating means obtains the SAPI from the first FIFO.

16. The data transmission apparatus according to claim 3 or 6, wherein the end flag of a previous frame is the start flag of a subsequent frame next to said previous frame.

17. The data transmission apparatus according to claim 3 or 6, further comprising a packet size processing means with a preset minimum packet size (mPS) and a maximum packet size (MPS), and if a input packet is longer than the MPS or shorter than the mPS, generating a error indication.

18. The data transmission apparatus according to claim 3 or 6, further comprising a line side packet loopback means to loopback the first type of frames extracted from the second frames into the first FIFO for test purpose.

19. The data transmission apparatus according to claim any one of the preceding claims, wherein said physics layer is one of SDH/SONET, simplified SDH/SONET, pesudo-synchronous digital hierarchy, and WDM.

20. The data transmission apparatus according to any one of the preceding claims, wherein said data packets from network layer are Ipv4, Ipv6, IS-IS, PPP packets, or MPEG data stream, each corresponding to a predetermined SAPI value, respectively, and said first type of frames are LAPS frames, and the second type of frames are SDH/SONET-like frames.

21. The data transmission apparatus according to claim 14, wherein said payload portion is SPE for SDH/SONET, and virtual containers as the sub-portions of payload.

22. The data transmission apparatus according to claim 20, wherein a DS codepoint is extracted from the network layer data to control the queue algorithm.

23. The data transmission apparatus according to claim 3, wherein said SAPI field is "0x04" for Ipv4 packets, "0x06" for Ipv6 packets, and "0xff" for PPP related packets or PPP/HDLC solution.

24. The data transmission apparatus according to claim 6, wherein said address field, control field, and SAPI field are "04 03 00 21" for Ipv4 packets, "04 03 0057" for Ipv6 packets, and "ff 03 0021" for Ipv4 packet of PPP/HDLC solution.

25. A data transmission apparatus for transmitting data packets formed by encapsulating a first type of frames in a second type of frames as payload with appropriate overheads, from a physical layer side device to a network layer side device, each of said first type of frames including a SAPI field, and an information field, said apparatus comprising:

a second receiving means for receiving the data packets from the physical layer side device;

a second de-framing means for removing the overheads, and extracting the first type of frames from the payload of the second type of frames;

a first de-framing means for extracting the address field and the data contained in the information field from the first type of frames;

determining means for comparing the value of the SAPI field with a set of preset values including at least a first value and a second value, and if the value of the SAPI field data matches the first value, determining the extracted data is of a first type, and if the value of the SAPI field matches the second value, determining the extracted data is of a second type; and

a second transmitting means for transmitting the extracted data packets and the determining result to the network layer side device.

26. The data transmission apparatus according to claim 25, wherein said first type of frames include start flag, address field, control field, information field including said data packets, FCS field, and end flag, and said SAPI field is at the address field.

27. The data transmission apparatus according to claim 26, wherein said SAPI field is of one single octet, and said control field is of one single octet, said SAPI is "0x04" for Ipv4 packets, "0x06" for Ipv6 packets, "0xff" for PPP/HDLC solution.

28. The data transmission apparatus according to claim 25, wherein said first type of frames include start flag, address field containing a frame type indicator, control field, SAPI field including said SAPI identifier, information field including said data packets, FCS field, and end flag to form the first type of frames.

29. The data transmission apparatus according to claim 28, wherein said address field is of one single octet, said control field is of one single octet, and said SAPI field is of two octets.

30. The data transmission apparatus according to claim 29, wherein determining means comprising a frame type recognizing means for extracting the frame type indicator from the address field to recognize the type of the first type of frames. type encapsulated in the SDH/SONET frames, if the frame type indicator is "0x04" , the received frames are determined to be LAPS frames; if the frame type indicator is "0xff" , the received frames are PPP frames.

31. The data transmission apparatus according to claim 30, wherein said determining means further comprising a SAPI extracting means for extracting the SAPI value from the SAPI field following the control field, if the frame type recognizing means determines the frame type indicator in the address field is "0x04" , which indicates the received frames are LAPS frames, the SAPI extracting means goes to the SAPI field to extract the SAPI value, which shows the type of the data packets, i.e., "0x0021" for Ipv4 data packets, "0x0057" for Ipv6 data packets; if the frame type recognizing means determines the frame type indicator in the address field is "0xff" , and the SAPI is "0021" , then the received frames are determined to be PPP frames, and can be sent for further PPP processing.

32. The data transmission apparatus according to claim 31, wherein said determining means perform the determining function of the first four octets of each of the first type of frames: the address field(one octet), the control field(one octet), and the SAPI

field(two octets), for facilitating 32-bit processing, the first four octets "04 03 00 21" represent Ipv4 packets, "04 03 00 57" represent Ipv6 packets, and "ff 03 00 21" represent Ipv4 of PPP/HDLC solution.

33. The data transmission apparatus according to any one of claims 27, 29, 31, and 32, further comprising a descrambling means for performing $X^{43}+1$ descrambling, said de-scrambling means includes a XOR gate and a 43-bit shift register, and the output bits is exclusive-ored with the input scrambled data bits to produce the unscrambled bits.

34. The data transmission apparatus according to claim 33, further comprising a pointer interpretation means for locating the start of the first type of frames encapsulating in the second type of frames indicated by the pointer.

35. The data transmission apparatus according to claim 34, wherein said second transmitting is a second FIFO for receiving and buffering the extracted data packets.

36. The data transmission apparatus according to claim 35, wherein said start flag and end flag are "0x7E".

37. The data transmission apparatus according to claim 36, wherein said first de-framing means removes inter-frame fill.

38. The data transmission apparatus according to claim 37, wherein said first de-framing means performs de-stuffing procedure to decode 0x7D,0x5E as 0x7E, and 0x7D,0x5D as 0x7D.

39. The data transmission apparatus according to claim 38, wherein the received FCS field is verified by calculating FCS checksum over all octets between the start flag and the end flag with generating polynomial: $1 + x + x^2 + x^4 + x^5 + x^7 + x^8 + x^{10} + x^{11} + x^{12} + x^{16} + x^{22} + x^{23} + x^{26} + x^{32}$.

40. The data transmission apparatus according to claim 39, wherein said extracted SAPI value is stored in the second FIFO.

41. The data transmission apparatus according to claim 40, wherein the end flag of a previous frame is the start flag of a subsequent frame next to said previous frame.

42. The data transmission apparatus according to claim 41, wherein said second FIFO has a preset minimum packet size(mPS) and a maximum packet size(MPS), and if a input packet is longer than the MPS or shorter than the mPS, generating a error indication.

43. The data transmission apparatus according to claim any one of the claims 25-42, wherein said physics layer is one of SDH/SONET, simplified SDH/SONET, pesudo-SDH, and WDM.

44. The data transmission apparatus according to any one of the claims 25-43, wherein said first type of frames are LAPS frames, and the second type of frames are SDH/SONET-like frames, and said extracted data packets therefrom are Ipv4, Ipv6, IS-IS, PPP packets, or MPEG data stream.

45. The data transmission apparatus according to claim 44, further comprising a connection management unit, said connection management unit includes a timer for monitoring if the period with no frame received exceeds a preset time, and a counter for counting the expiring times of the timer, and if the counter counts to a preset value, the connection management unit determines there is a connection error, and reports to network management entity in global routing engine..

46. The data transmission apparatus according to claim 45, wherein the preset time of timer is set to 1 second, and the preset count value of the counter is set to 3 defaultly.

47. A data transmission apparatus for transmitting data packets between a network layer side device and a physical layer side device comprising the data transmission apparatus according to any one of claims 1-24 and data transmission apparatus according to any one of claims 25-46.

48. The data transmission apparatus according to claim 47, further comprising an embedded CPU for performing the processes involved in the first framing/de-framing means.

49. The data transmission apparatus according to claim 48, further comprising a network layer processor, said network layer processor includes a PPP processing unit for either performing PPP(LCP,NCP) processing or transferring PPP packet to global routing engine on the data transmitted from said second FIFO, when said determining means determines that the SAPI indicates that the received packets is PPP packets and need to be further processed.

50. A router device comprising a plurality of line cards, and at least one of line cards includes the data transmission apparatus according to any one of claims 1-24 and data transmission apparatus according to any one of claim 25-46.

51. The router according to claim 52, wherein said at least one line card further comprises an embedded CPU for performing the processes involved in the first framing/de-framing means.

52. The router according to claim 51, wherein said at least one line card further comprises a network layer processor, said network layer processor includes a PPP processing unit for either performing PPP(LCP,NCP) processing or transferring PPP packet to global routing engine on the data transmitted from said second FIFO, when said determining means determines that the SAPI indicates that the received packets is PPP packets and need to be further processed.

53. The router device according to claim 52, further comprising a global CPU for both routing engine and network management in each of the line cards.

54. A data transmission method for transmitting data packets from a network layer side device and a physical layer side device, comprising the steps of:
receiving the data packets of a certain type from the network layer side device;
recognizing the type of the data packets and generating a SAPI identifier according to the recognized type;

first framing step, for encapsulating a SAPI field including said SAPI identifier and an information field including said data packets into a frame, to form a first type of frames;

second framing step, for encapsulating said first type of frames into a payload portion, inserting appropriate overheads, to form a second type of frames; and

outputting said second type of frames to the physical layer side device.

55. The data transmission method according to claim 54, wherein said first framing step encapsulates said data in a format of start flag, SAPI field including said SAPI identifier as the address field, control field, information field including said data packets, FCS field, and end flag to form the first type of frames.

56. The data transmission method according to claim 55, wherein said SAPI field is of one single octet, and said control field is of one single octet.

57. The data transmission method according to claim 54, wherein said first framing step encapsulates said data in a format of start flag, address field, control field, SAPI field including said SAPI identifier, information field including said data packets, FCS field, and end flag to form the first type of frames.

58. The data transmission method according to claim 57, further comprising a frame type indicator generating step for generating an indicator which indicates the type of said first type of frames, and said frame type indicator is inserted in the address field in said first framing step.

59. The data transmission method according to claim 58, wherein said address field is of one single octet, said control field is of one single octet, and said SAPI field is of two octets.

60. The data transmission method according to claim 56 or 59, further comprising a self-synchronizing scrambling step for performing $X^{43}+1$ scrambling on the transmitted first type of frames.

61. The data transmission method according to claim 60, wherein said start flag and end flag are "0x7E".

62. The data transmission method according to claim 61, wherein in said first framing step inter-frame fill is performed and FIFO error recovery is transmitted.

63. The data transmission method according to claim 62, wherein said first framing step performs transparency processing(octet stuffing) to encode 0x7E as 0x7D,0x5E, and 0x7D as 0x7D,0x5D.

64. The data transmission method according to claim 63, wherein said first framing step calculates 32 bit frame check sequence field over all octets within the frame except the start flag and the end flag and the FCS field itself, with generating polynomial: $1 + x + x^2 + x^4 + x^5 + x^7 + x^8 + x^{10} + x^{11} + x^{12} + x^{16} + x^{22} + x^{23} + x^{26} + x^{32}$.

65. The data transmission method according to claim 64, wherein the end flag of a previous frame is the start flag of a subsequent frame next to said previous frame.

66. The data transmission method according to claim 65, wherein said input data packets are buffered for rate adaptation before being processed..

67. The data transmission method according to any one of claims 54-66, wherein said physics layer is one of SDH/SONET, simplified SDH/SONET, pesudo-synchronous digital hierarchy, and WDM.

68. The data transmission method according to any one of claims 54-67, wherein said data packets from network layer are Ipv4, Ipv6, IS-IS, PPP packets, or MPEG data stream, each corresponding to a predetermined SAPI value, respectively, and said first type of frames are LAPS frames, and the second type of frames are SDH/SONET-like frames.

69. The data transmission method according to claim 56, wherein said SAPI field is "0x04" for Ipv4 packets, "0x06" for Ipv6 packets, and "0xff" for PPP/HDLC solution .

70. The data transmission method according to claim 59, wherein said address field, control field, and SAPI field are "04 03 00 21" for Ipv4 packets, "04 03 0057" for Ipv6 packets, and "ff 03 0021" for Ipv4 packet of PPP/HDLC solution.

71. A data transmission method for transmitting data packets formed by encapsulating a first type of frames in a second type of frames as payload with appropriate overheads, from a physical layer side device to a network layer side device, each of said first type of frames including a SAPI field, and an information field, said method comprising the steps of:

receiving the data packets from the physical layer side device;

second de-framing step, for removing the overheads, and extracting the first type of frames from the payload of the second type of frames;

first de-framing step, for extracting the SAPI field and the data contained in the information field from the first type of frames;

comparing the value of the SAPI field with a set of preset values including at least a first value and a second value, and if the value of the SAPI field data matches the first value, determining the extracted data is of a first type, and if the value of the SAPI field matches the second value, determining the extracted data is of a second type; and

transmitting the extracted data packets and the determining result to the network layer side device.

72. The data transmission method according to claim 71, wherein said first type of frames include start flag, address field, control field, information field including said data packets, FCS field, and end flag, and said SAPI field is at the address field.

73. The data transmission method according to claim 72, wherein said SAPI field is of one single octet, and said control field is of one single octet, said SAPI is "0x04" for Ipv4 packets, "0x06" for Ipv6 packets, "0xff" for PPP/HDLC solution.

74. The data transmission method according to claim 71, wherein said first type of frames include start flag, address field containing a frame type indicator, control field, SAPI field including said SAPI identifier, information field including said data packets, FCS field, and end flag to form the first type of frames.

75. The data transmission method according to claim 74, wherein said address field is of one single octet, said control field is of one single octet, and said SAPI field is of two octets.

76. The data transmission method according to claim 75, wherein said comparing and determining step comprising a frame type recognizing step for extracting the frame type indicator from the address field to recognize the type of the first type of frames. type encapsulated in the SDH/SONET frames, if the frame type indicator is "0x04", the received frames are determined to be LAPS frames; if the frame type indicator is "0xff", the received frames are PPP frames.

77. The data transmission method according to claim 76, wherein said comparing and determining step further comprising a SAPI extracting means for extracting the SAPI value from the SAPI field following the control field, if the frame type recognizing means determines the frame type indicator in the address field is "0x04", which indicates the received frames are LAPS frames, the SAPI extracting means goes to the SAPI field to extract the SAPI value, which shows the type of the data packets, i.e., "0x0021" for Ipv4 data packets, "0x0057" for Ipv6 data packets; if the frame type recognizing means determines the frame type indicator in the address field is "0xff", and the SAPI is "0021", then the received frames are determined to be PPP frames, and can be sent for further PPP processing.

78. The data transmission apparatus according to claim 76, wherein said comparing and determining step perform the determining function of the first four octets of each of the first type of frames: the address field(one octet), the control field(one octet), and the SAPI field(two octets), for facilitating 32-bit processing, the first four octets "04 03 00 21" represent Ipv4 packets, "04 03 00 57" represent Ipv6 packets, and "ff 03 00 21" represent corresponding PPP solution.

79. The data transmission method according to any one of claims 73, 75, 77, and 78, further comprising a descrambling step for performing $X^{43}+1$ descrambling to produce the unscrambled bits.

80. The data transmission method according to claim 79, wherein said start flag and end flag are "0x7E".

81. The data transmission method according to claim 80, wherein said first de-framing step removes inter-frame fill.

82. The data transmission method according to claim 81, wherein said first de-framing step performs de-stuffing procedure to decode 0x7D,0x5E as 0x7E, and 0x7D,0x5D as 0x7D.

83. The data transmission method according to claim 82, wherein the received FCS field is verified by calculating FCS checksum over all octets between the start flag and the end flag with generating polynomial: $1 + x + x^2 + x^4 + x^5 + x^7 + x^8 + x^{10} + x^{11} + x^{12} + x^{16} + x^{22} + x^{23} + x^{26} + x^{32}$.

84. The data transmission method according to claim 83, wherein the end flag of a previous frame is the start flag of a subsequent frame next to said previous frame.

85. The data transmission method according to claim 84, wherein the output data packets are buffered for rate adaptation before being transmitted to network layer.

86. The data transmission method according to claim any one of the claims 71-85, wherein said physics layer is one of SDH/SONET, simplified SDH/SONET, pseudo-synchronous digital hierarchy, and WDM

87. The data transmission method according to any one of the claims 71-86, wherein said first type of frames are LAPS frames, and the second type of frames are SDH/SONET-like frames, and said extracted data packets therefrom are Ipv4, Ipv6, IS-IS, PPP packets, or MPEG data stream.